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A map of the stars

Advanced concepts and data relationships

Astronomers study the H-R diagram using many variables simultaneously:

- Effective temperature (*K*)
- Spectral class
- Absolute magnitude - explained earlier
- Luminosity (relative to the Sun)
- Radius and colour index

a. **Harvard spectral classification scheme**: a way of classifying stars based on their colour and temperature, often remembered by the mnemonic *"Oh, Be A Fine Girl, Kiss Me!"* (O, B, A, F, G, K, M).[1]

The colour of a star corresponds to its spectral type, from hot blue O-type stars to cooler red M-type stars. This simple colour coding reflects temperature and, indirectly, other properties like mass and luminosity.[2,3]

Class	Colour	Temperature Range (K)	Mnemonic
O	blue	> 30,000	**Oh**
B	blue white	10,000–30,000	**Be**
A	white	7,500–10,000	**A**
F	yellow white	6,000–7,500	**Fine**
G	yellow	5,200–6,000	**Girl**
K	orange	3,700–5,200	**Kiss**
M	red	< 3,700	**Me!**

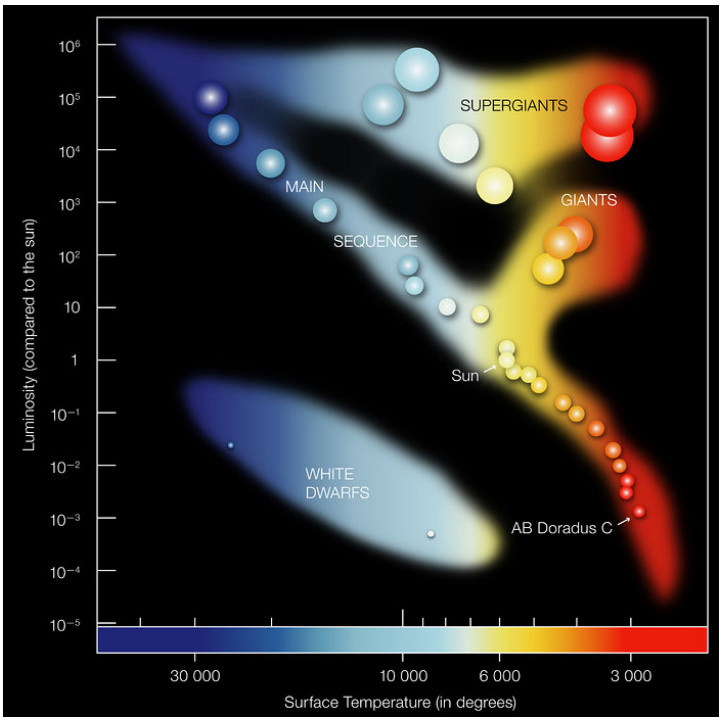
b. Stellar mass, lifetime and fate: Each star's position on the H-R diagram is largely determined by its mass, which dictates how it lives and dies. Look at this mini chart:

Star mass (× Solar mass)	Lifetime (years)	Post-main-sequence stage(s)	Final stage	H-R diagram location	Key process
0.5	~80 billion	subgiant → red giant	white dwarf	lower main sequence → subgiant (upwards) → red giant branch (up + right)	core H → He burning, envelope expansion
1.0 (Sun)	~10 billion	red giant → horizontal branch → AGB	white dwarf	main sequence → red giant (up + right) → horizontal branch (left + slightly down) → AGB (up + right) → white dwarf (down + left)	core He burning, envelope expansion, mass loss
2–3	~1 billion	blue giant → red giant	white dwarf / nova	upper main sequence → blue giant (slightly up + left) → red giant (up + right) → instability strip (back and forth, pulsations)	core He burning, pulsations (cepheid variables)
5.0	~100 million	supergiant → blue/red supergiant	neutron star (often, but not always)	upper main sequence → blue/red supergiant branch (up + right / slightly left) → neutron star (end point, off diagram)	core collapse, type II supernova
10–20	~10 – 20 million	blue supergiant → red supergiant	neutron star	upper HR diagram → blue supergiant (up + left) → red supergiant (up + right) → neutron star / black hole (end point)	core collapse, type II supernova
>20	~10 million	luminous blue variable → wolf-rayet → red supergiant	black Hole (often, but not always; depends on the type of supernova)	top left → luminous blue variable (up + slightly right) → wolf-rayet (slightly left) → red supergiant (up + right) → black hole (end point)	core collapse, strong stellar winds, type II supernova

Notice how more massive stars live fast and die young, while smaller stars like the Sun evolve more slowly. The main sequence you plotted is essentially a "stellar highway" showing stars at different masses in the prime of their lives. The clusters of red giants and white dwarfs show what happens when stars exit that highway.

c. Luminosity relative to the Sun: By analysing clustering, scaling, and correlations, you are practicing the same statistical reasoning used in astronomy and mathematics. Adding additional scales, like radius or colour, reveals deeper patterns, which is a powerful demonstration of how multiple dimensions of data can coexist in a single visual representation.

d. Optional activity: Annotate your H-R plot to mark the main sequence, red giants, and white dwarfs. Reflect on why stars cluster in these regions.[4]



Example of an annotated H-R diagram highlighting main sequence, red giants, and white dwarfs. ©*ESO*

For further exploration, students can use the **H-R Diagram Explorer** developed by the GEAS Laboratory at New Mexico State University to simulate how stars evolve over time.[5]

References

[1] Harvard spectral classification scheme: https://lweb.cfa.harvard.edu/~pberlind/atlas/htmls/note.html
[2] Stellar classification: https://en.wikipedia.org/wiki/Stellar_classification
[3] Mnemonics for Harvard spectral classification scheme: http://www.star.ucl.ac.uk/~pac/obafgkmrns.html
[4] The Hertzsprung-Russel diagram from the European Southern Observatory (ESO): https://www.eso.org/public/images/eso0728c/
[5] The H-R diagram explorer of the GEAS laboratory: http://astronomy.nmsu.edu/geas/labs/hrde/hrd_explorer.html